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6	0	(345/788-801.ccls.) and (gps and (water near (deep or depth or transducer)))	USPAT	2003/03/03 10:27
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8	0	(345/788-801.ccls.) and (gps same (water or underwater or (under adj1 water)))	USPAT	2003/03/03 10:29
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-	448	transducer and gps	USPAT	2003/02/28 13:32
-	3	(transducer and gps).ab.	USPAT	2003/02/28 13:41
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-	1	("5,012,457").PN.	USPAT	2003/02/28 13:47
-	1	("5,362,263").PN.	USPAT	2003/02/28 13:47
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-	16	5283767.URPN.	USPAT	2003/02/28 15:06
-	0	6198692.URPN.	USPAT	2003/02/28 15:21
-	7	((gps adj1 device) and (sea adj1 level))	USPAT	2003/02/28 15:25
-	1	((gps adj1 device) and (navigation near sea))	USPAT	2003/02/28 15:25
-	0	((gps adj1 device) and (navigation near underwater))	USPAT	2003/02/28 15:26
-	0	((gps adj1 device) and (navigation near (under adj1 water)))	USPAT	2003/02/28 15:26
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-	0	((gps adj1 device) and (navigation with (submarine)))	USPAT	2003/02/28 15:28
-	0	((gps adj1 device) and (navigation with (fish\$3)))	USPAT	2003/02/28 15:28
-	0	((gps adj1 device) and (navigation with (boat\$3)))	USPAT	2003/02/28 15:28
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-	28	gps and (measur\$4 same (depth near water))	USPAT	2003/03/03 09:05
-	41	NEXRAD or GOES-9	USPAT	2003/03/03 09:05

09/587867



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**Robinson et al.**

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**(45) Date of Patent:** **Apr. 30, 2002**

(54) **VEHICLE SPECIFIC HAZARD ESTIMATION, PRESENTATION, AND ROUTE PLANNING BASED ON METEOROLOGICAL AND OTHER ENVIRONMENTAL DATA**

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**701/210**

(58) **Field of Search:** **701/3, 14, 201,**  
**701/202, 210, 211, 1; 702/3; 342/26**

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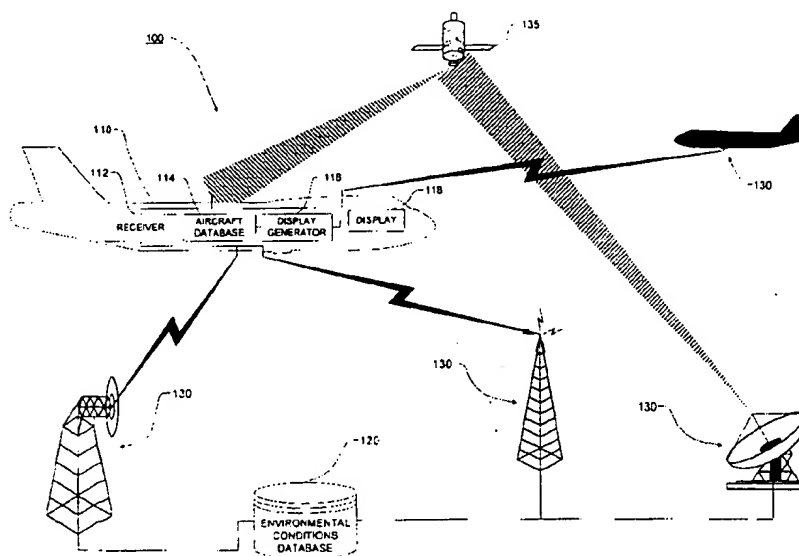
**Primary Examiner—Michael J. Zanelli**

**(74) Attorney, Agent, or Firm—Kaufman & Canoles**

(57) **ABSTRACT**

This invention combines meteorological and other environmental data with data specific to a particular craft or vehicle, such as, for example, the weight, speed, response characteristics, propulsion, mode of propulsion, and configuration, of a particular aircraft, and produces a simplified display map showing environmental conditions data as the environmental conditions data relates to that specific vehicle. The environmental conditions data is presented on the display map in the form of environmental condition annotations that have different coloring, shading, and/or iconization as determined by the type, severity, and area of the various environmental conditions relative to the vehicle. This invention separately provides travel route optimization for a particular craft or vehicle based on the combination of meteorological and other environmental data with data specific to the particular craft or vehicle. The travel route may be optimized based on default criteria or criteria selected by a user, such as, for example, best fuel economy, most comfortable ride, fastest traverse of a particular region, and/or changing configuration of the particular craft or vehicle. The travel route may be altered or updated by this invention based on either a request from the user or a change in either the environmental conditions or the characteristics of the particular craft or vehicle.

**51 Claims, 9 Drawing Sheets**



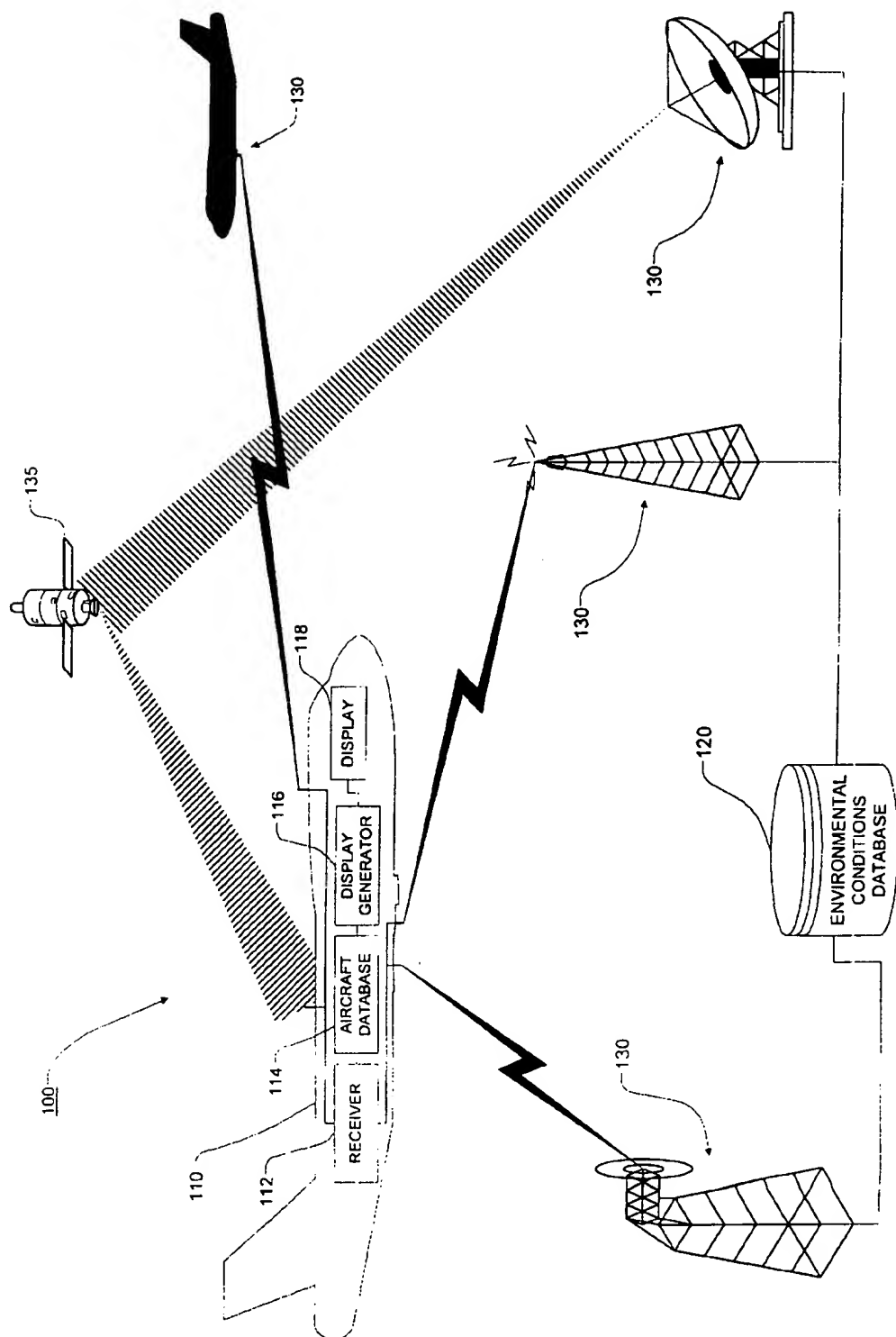


Fig. 1

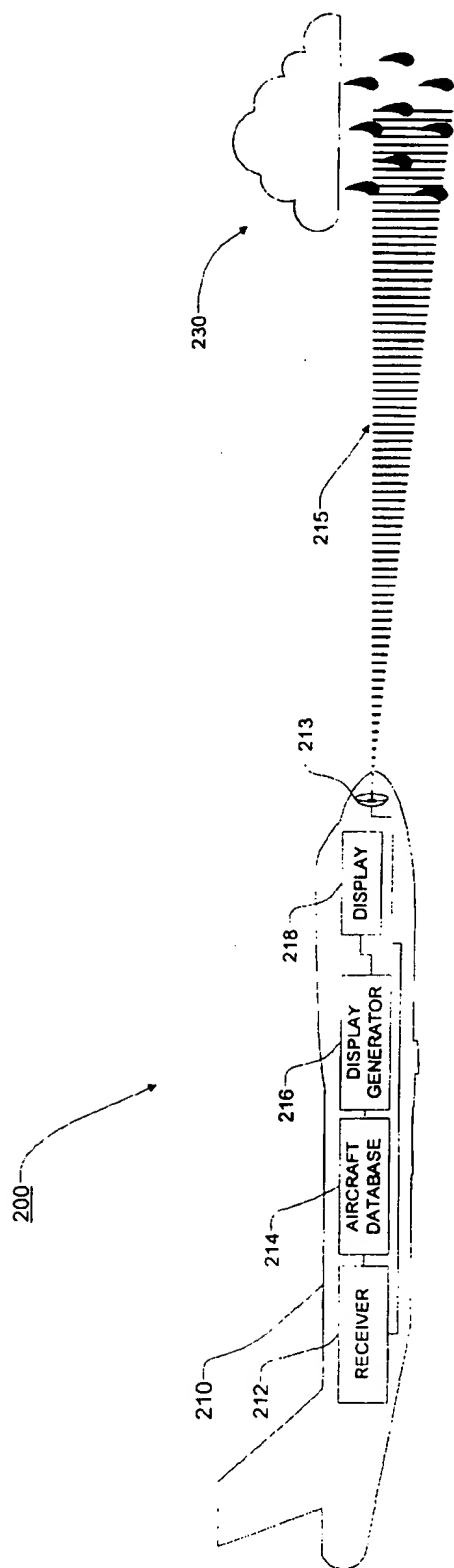


Fig. 2



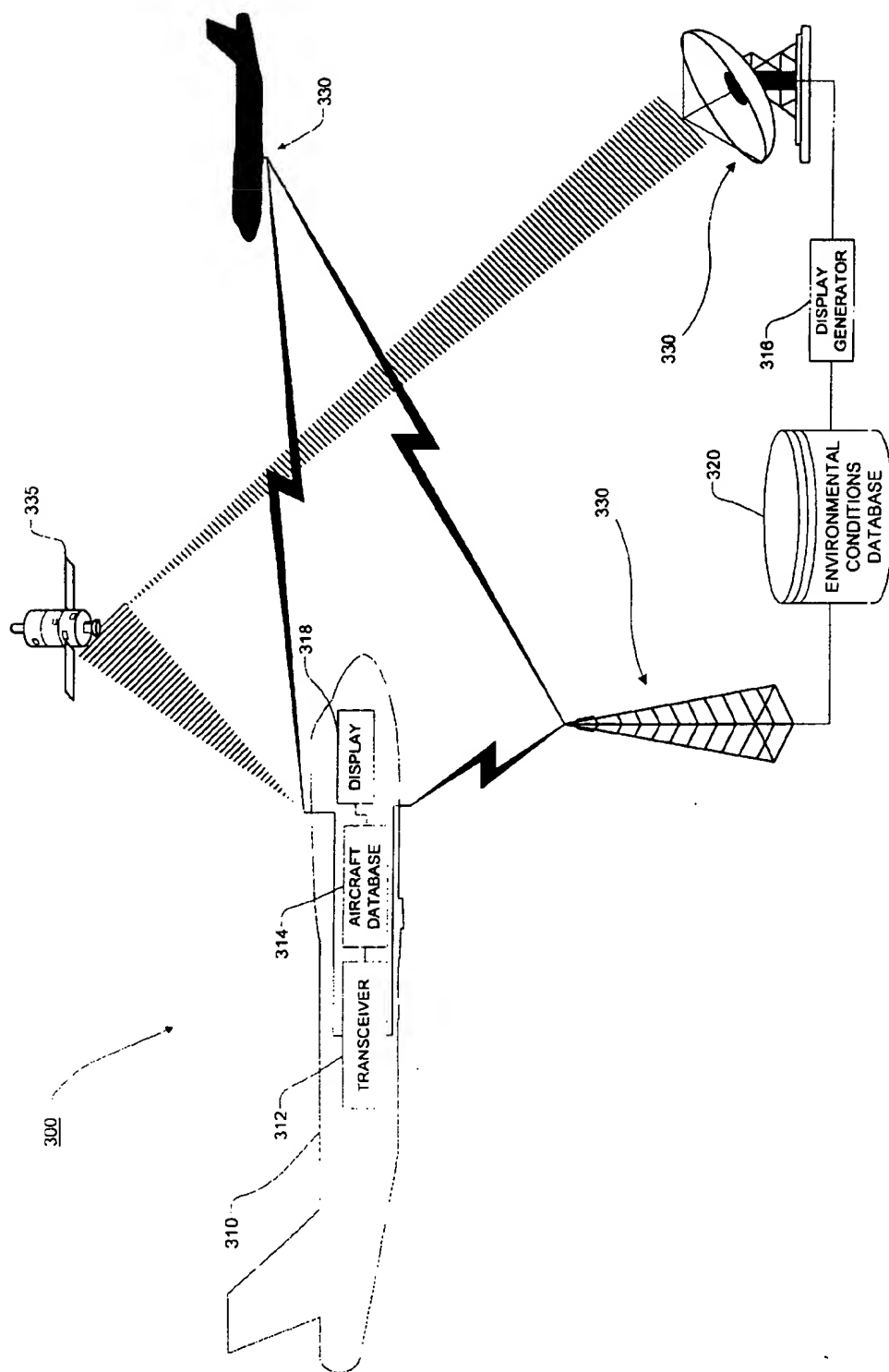


Fig. 3

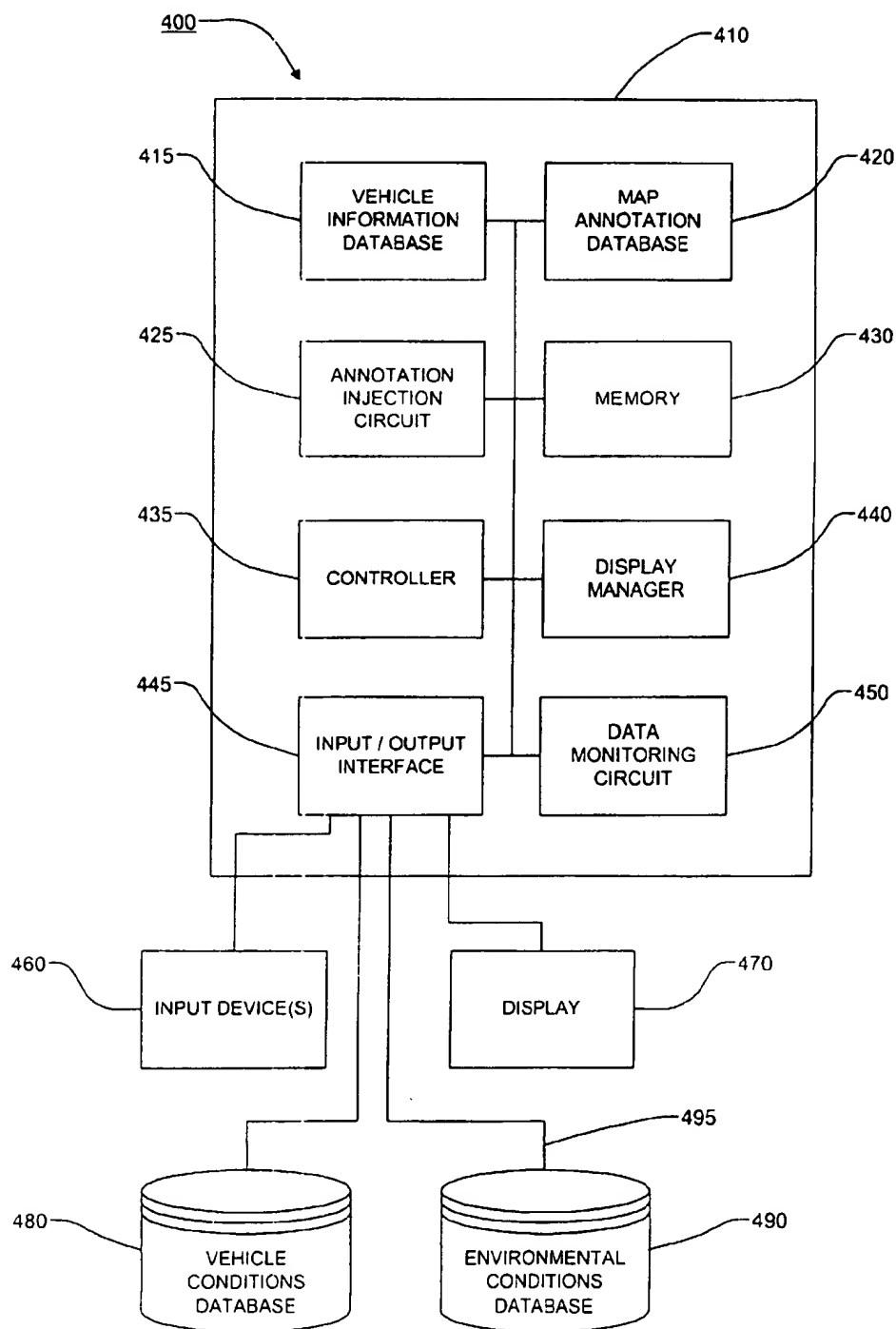


Fig. 4

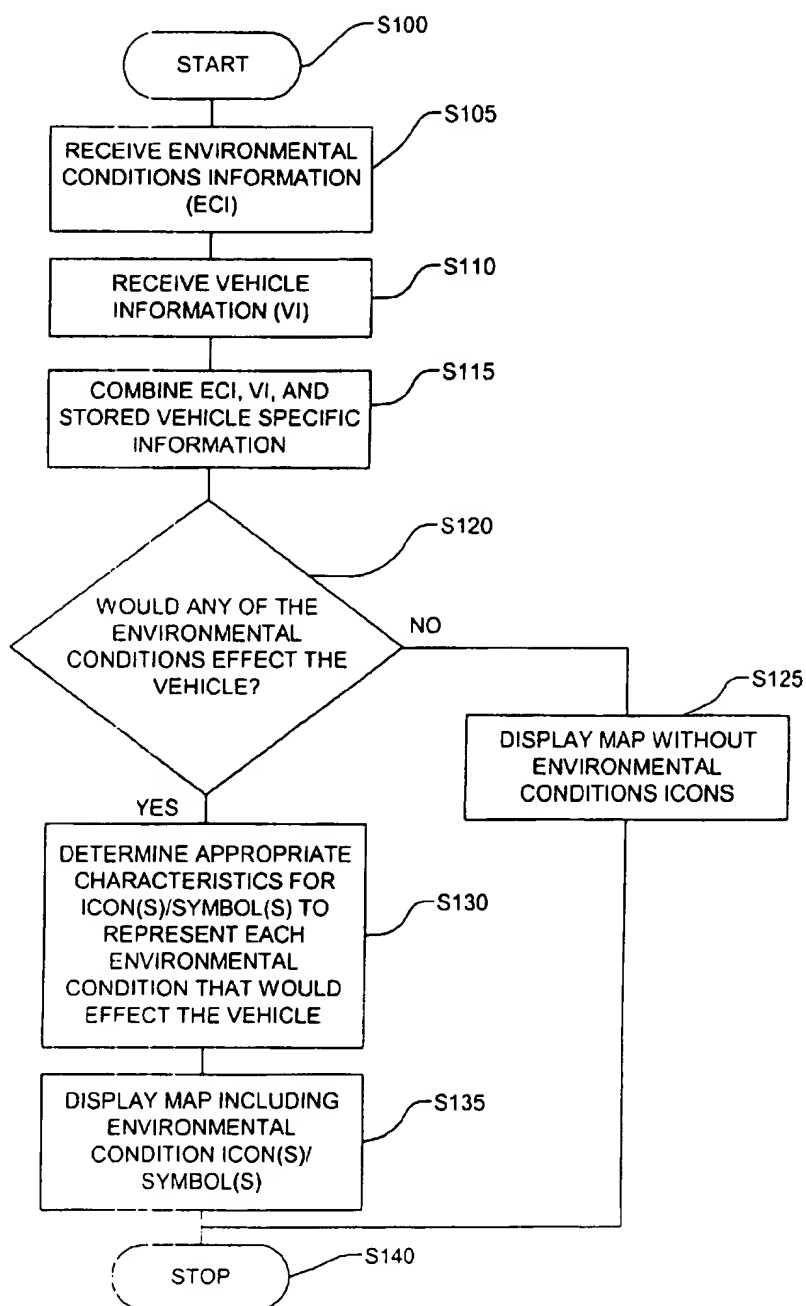


Fig. 5

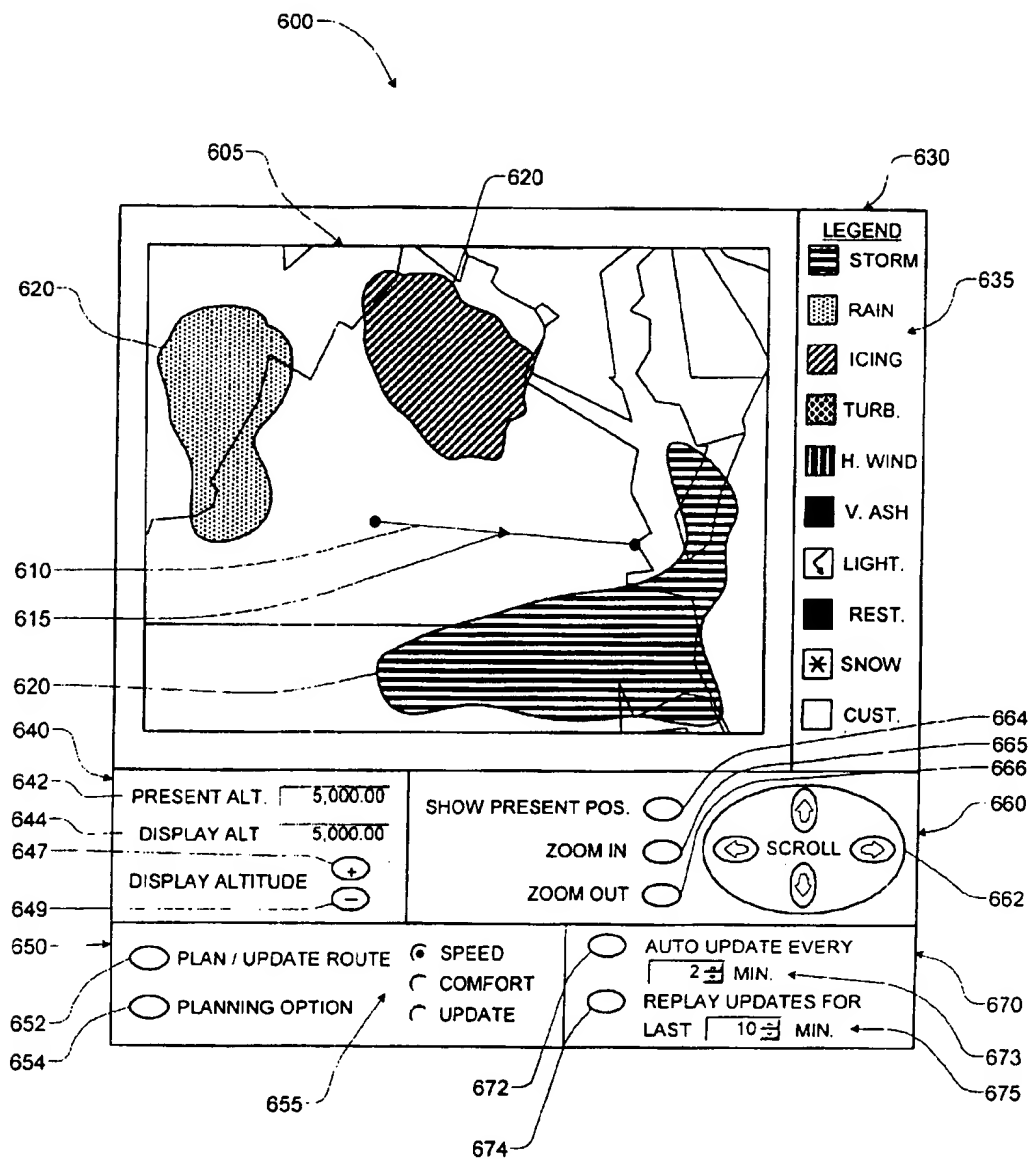


Fig. 6

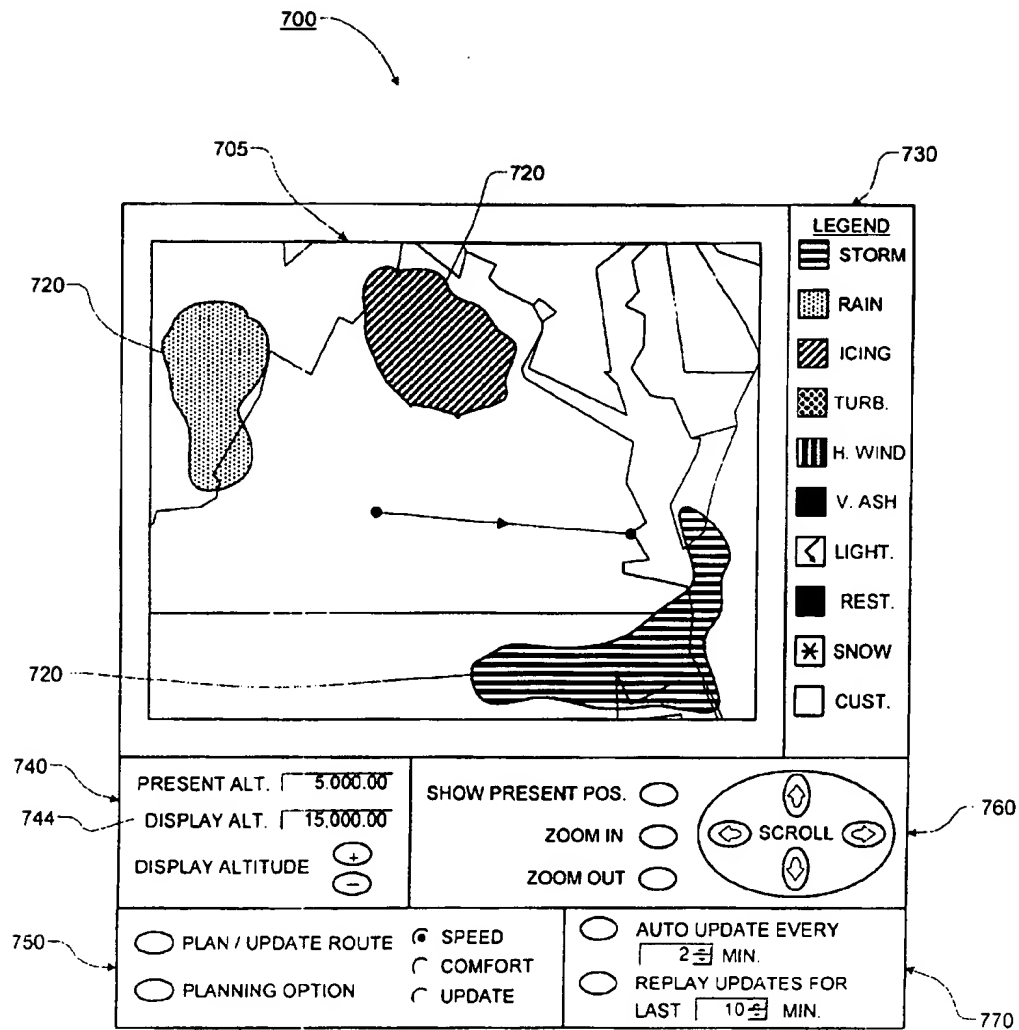


Fig. 7

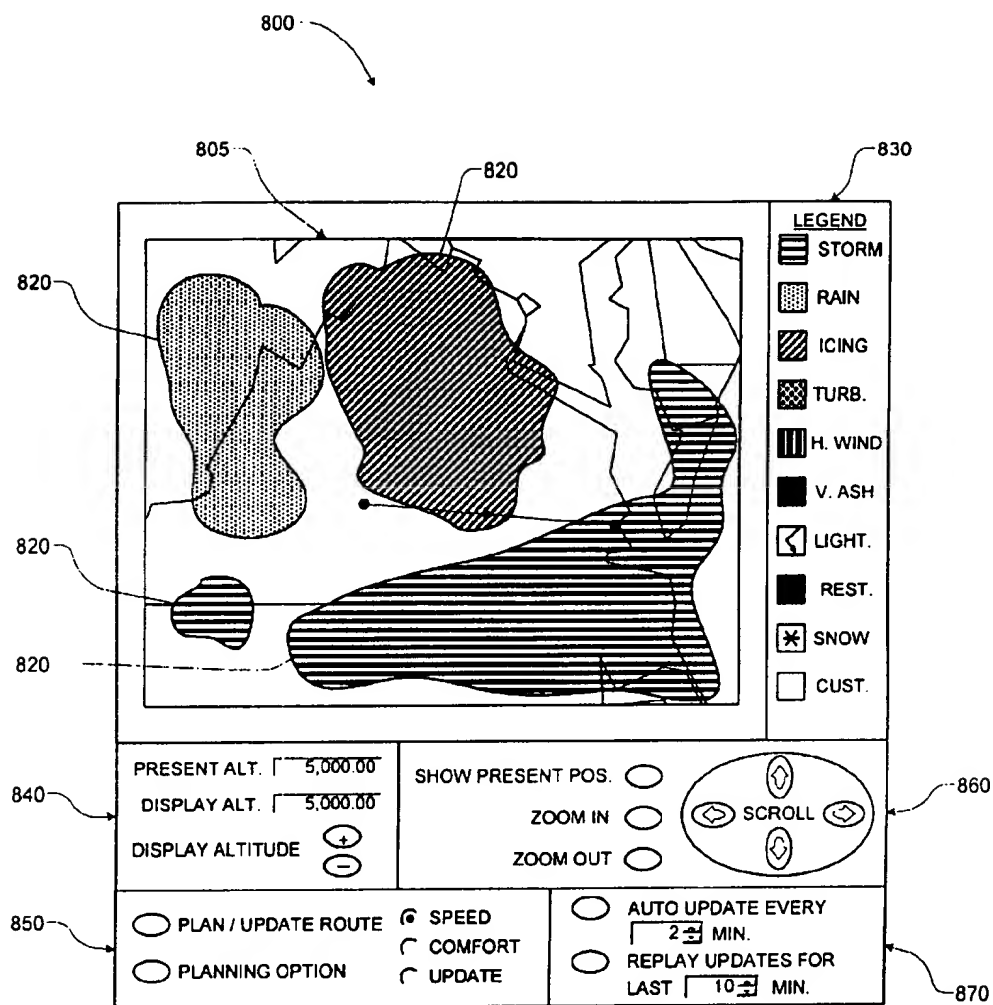


Fig. 8

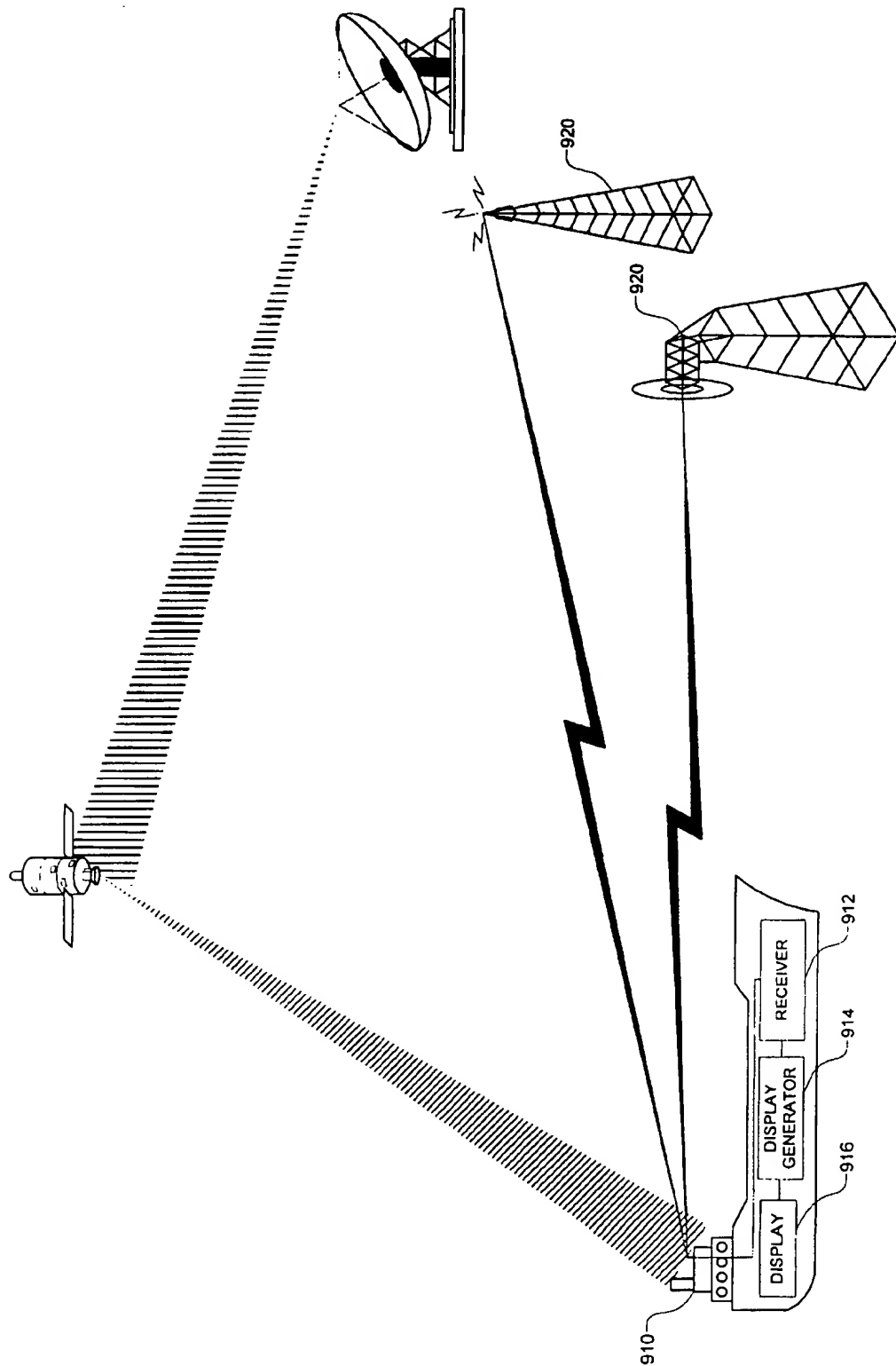


Fig. 9

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# VEHICLE SPECIFIC HAZARD ESTIMATION, PRESENTATION, AND ROUTE PLANNING BASED ON METEOROLOGICAL AND OTHER ENVIRONMENTAL DATA

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

This invention relates to the display of meteorological and other environmental data.

### 2. Description of Related Art

Whether planning a flight, flying a pre-planned route, or altering a flight en route, pilots need up-to-date, accurate information on the environmental conditions that they are likely to encounter. Environmental conditions can include, for example, meteorological and other environmental conditions, such as, storms, rain, turbulence, lightning, icing, fog, volcanic ash, wind speed, wind direction, wind variation, or the like. Before a flight begins, available environmental conditions information must, at the very least, alert the pilot to the environmental conditions for the departure location, the arrival location, and the intended travel route. During the flight, the pilot must be able to access updated environmental conditions information not only for the present location of the aircraft, but also for the remainder of the intended travel route, the arrival location, and any alternate routes that may be used in case of emergency.

To accomplish this, the pilot typically receives environmental conditions information in the form of various maps, printouts, and/or displays that detail environmental conditions that the aircraft is likely to encounter. Some of the information sources, such as, for example, pressure or jet-stream maps, make the pilot aware of environmental conditions that affect the aircraft directly, such as, for example, wind speed. Other sources of information, such as, for example, radar reflectivity maps, or Nexrad data, advise the pilot of conditions that affect the aircraft indirectly. For example, raindrops, which do not affect the aircraft directly, appear as areas of high reflectivity on radar reflectivity maps and infer areas of turbulence.

The pilot must then compare all of the environmental conditions information that he or she receives with his or her knowledge, experience, and judgment, to determine a navigable course through the maze of environmental conditions.

To help the pilot to assimilate the vast amount of information, it is known to transmit weather data to the cockpit of an aircraft so that the weather data can be displayed and periodically updated. For example, in U.S. Pat. No. 5,265,024, to Crabill et al., describes a system for providing systematic, updated, weather information from the ground to the pilot. The '024 patent includes processor and display systems that display weather data in map-style depictions and as alphanumeric formats. The '024 patent also describes a display that provides overlays of mosaicked ground weather maps, lightning, and other Significant Meteorological Statements (Sigmets).

As an example of displaying environmental conditions information to a pilot, it is known to use enhanced weather radar to measure wind variations in an area ahead of an aircraft. The wind variation measurements are then processed to determine regions of potentially hazardous wind shear. These determined regions are then displayed on a map as a series of variable sized, color-coded pie shapes. The different color codes represent different intensities of wind variation, while the size of each pie shape shows an approxi-

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mate size of the hazardous area. By understanding the color codes and the size variations of these displayed pie shapes, the pilot can take appropriate actions to negotiate a way through a hazardous area or avoid the hazardous area completely, without flying into another hazardous area.

## SUMMARY OF THE INVENTION

When making flight decisions, the pilot cannot merely consider environmental conditions information in a vacuum, the pilot must also consider aircraft specific characteristics, such as, for example, the physical size, weight, propulsion, mode of propulsion, performance characteristics, and performance limitations of the aircraft that he or she is flying. Performance characteristics can include, for example, the type of control systems, control surfaces, the presence and functionality of any automated systems, and both the longitudinal and lateral aerodynamics of the aircraft. Performance limitations can include, for example, the aircraft's maximum speed and Mach number, buffet speed, operational ceiling, maximum weight, center of gravity, as well as the structural and mechanical limitations of the aircraft.

Some of the aircraft specific characteristics, such as the aircraft's mode of propulsion, are characteristics that are typically static and do not change during flight. Other of the aircraft specific characteristics, such as the aircraft's weight, are typically dynamic, and change during flight.

Furthermore, certain types of environmental conditions affect different aircraft in different ways and to varying degrees while other types of environmental conditions affect all aircraft in much the same way and to much the same degree. For example, storms, turbulence, icing, fog, volcanic ash, winds, or the like, can affect a large, jet-engine aircraft differently than a small, propeller-driven aircraft. In contrast, environmental conditions, such as, for example, ground terrain, structures, lightning, or the like, can affect both large and small aircraft alike.

To illustrate, a large multi-engine passenger aircraft might be able to fly, safely and comfortably, through an area of turbulence that would cause a small single-engine aircraft to be thrown about quite violently. However, that same, large multi-engine passenger aircraft will react differently when it is loaded with passengers, fuel, or cargo than it will when it is relatively empty. Furthermore, a private jet, with an excess of available power, can fly in conditions that a small, single engine, propeller-driven aircraft cannot. But, both large and small aircraft alike can be catastrophically affected by, for example, a lightning strike.

As a further illustration, the altitude of the aircraft may determine whether and to what extent the aircraft encounters certain environmental conditions, such as turbulence. For example, there might be an area of thunderstorms that can be avoided if the pilot flies over the storms at a higher altitude. Unfortunately, the operational ceiling of the aircraft may not allow the aircraft to fly high enough to travel over the storms. Alternatively, the operational ceiling of the aircraft may be limited because of certain performance limitations of the aircraft. Additionally, the pilot of the aircraft may not be allowed, if, for example, the pilot is only instrument flight rules (IFR) rated, to fly above a predetermined altitude. Furthermore, air traffic control (ATC) may not allow the pilot to make an altitude change.

Therefore, because the impact of any given set of environmental conditions is not the same for every aircraft, and different aircraft react very differently to different environmental conditions, the pilot must consider not only the present environmental conditions that the aircraft is about to



encounter, but also the specific flight characteristics of the aircraft that he or she is flying.

Thus, a system that combines environmental conditions information with aircraft specific information and produces a simplified display map showing any environmental conditions that are relevant to a particular aircraft, improves pilot awareness, reduces the workload on the pilot, and improves the safety level to the aircraft, the pilot, and any passengers and/or cargo onboard.

Thus, in contrast to the example of merely displaying environmental conditions information described above, this invention allows the pilot to look at the display map without having to determine, for example, which color-coded pie shapes represent wind variations that are intense enough to adversely affect his or her particular aircraft. To the contrary, the display map of this invention only displays environmental conditions that exceed a determined threshold and can actually affect the pilot's particular aircraft. Thus, in contrast to the example described above, the display map of this invention will only show areas of wind variation that are intense enough to adversely affect the pilot's aircraft.

This invention also optimizes a travel route based on both environmental conditions information and aircraft specific information. The travel route may be optimized based on default criteria or criteria selected by the pilot, such as, for example, best fuel economy, most comfortable ride, fastest traverse of a particular region, and/or changing configuration of the aircraft. The travel route may be altered or updated by this invention based on either a request from the user or a change in either the environmental conditions or the aircraft characteristics.

In various exemplary embodiments, the systems and methods of this invention are able to produce projected dynamic vehicle information such that the status of certain of the aircraft characteristics, such as, for example, the aircraft's weight, can be projected for at least one point along a travel route.

It should be appreciated that the embodiments described above involve displaying environmental conditions data relative to a specific aircraft. However, in various exemplary embodiments of this invention, the environmental conditions data is processed and displayed in other vehicles, such as, for example, helicopters, watercraft, hovercraft, automotive vehicles, or the like.

When the vehicle is, for example, an aircraft, the environmental conditions information may include, for example, cloud type, cloud altitude, visibility, storms, rain, precipitation, turbulence, lightning, icing, fog, volcanic ash, wind speed, wind direction, wind variation, temperature, restricted areas, or the like. It should also be appreciated that the environmental conditions information is displayed relative to each particular aircraft's attributes, such as, for example, the physical size, weight, direction, speed, propulsion, mode of propulsion, response characteristics, performance characteristics, performance limitations, or the like of the aircraft.

When the vehicle is, for example, a watercraft, the environmental conditions information may include, for example, water temperature, water depth, water conditions, wave height, wind speed, wind direction, water current, water undercurrent data, or the like. It should also be appreciated that the environmental conditions information is displayed relative to each particular watercraft's attributes, such as, for example, size, weight, speed, propulsion, mode of propulsion, hull design, draft, performance characteristics, response characteristics, or the like.

When the vehicle is, for example, an automotive vehicle, the environmental conditions information may include, for example, weather conditions, wind speed, wind direction, accumulated precipitation information, road conditions, grade of terrain traversed, or the like. It should also be appreciated that the environmental conditions information is displayed relative to each particular automotive vehicle's attributes, such as, for example, two wheel or four wheel drive, gross vehicle weight, speed, height, center of gravity, or the like. If, for example, the vehicle is a tractor-trailer, the display may include wind speed and direction information so that a driver can avoid areas of crosswinds that are strong enough to tip the vehicle or force the vehicle off of a road.

Accordingly, this invention provides apparatuses, systems, and methods that present a user with a simplified environmental conditions map based on a scientific and technical analysis of both environmental conditions information and data specific to the vehicle that the user is operating.

This invention separately provides apparatuses, systems, and methods that produce a simplified, integrated, iconized map including environmental conditions information indicating the location, spatial extent, and severity of each environmental condition.

This invention separately provides apparatuses, systems, and methods that update vehicle specific data to reflect changes to the vehicle's weight, performance characteristics, and/or configuration.

This invention separately provides apparatuses, systems, and methods that simplify the route-planning task by suggesting optimized routings based on minimizing certain parameters.

This invention separately provides apparatuses, systems, and methods that plot and/or update a travel plan using both environmental conditions information and data specific to the vehicle that the user is operating.

This invention separately provides apparatuses, systems, and methods that automatically suggest courses of travel, either prior to departure or while en route, through or around various environmental conditions based on the specific characteristics of a particular vehicle.

This invention separately provides apparatuses, systems, and methods that optimize a course around various environmental conditions based on specific criteria, such as, for example, best fuel economy, most comfortable ride, fastest traverse of a particular region, and/or changing configuration of the vehicle.

This invention separately provides apparatuses, systems, and methods that can be used prior to departure or onboard a vehicle to interpret weather and/or environment data that is transmitted or broadcast to the vehicle.

This invention separately provides apparatuses, systems, and methods that provide the user with improved situational awareness of hazards to the user's specific vehicle.

This invention separately provides apparatuses, systems, and methods that improve safety by reducing the impact of adverse environment conditions on a specific vehicle.

These and other features and advantages of this invention are described in or are apparent from the following detailed description of the exemplary embodiments.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The exemplary embodiments of this invention will be described in detail, with reference to the following figures, wherein:

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FIG. 1 shows a first exemplary embodiment of the environmental conditions display system according to this invention;

FIG. 2 shows a second exemplary embodiment of the environmental conditions display system according to this invention;

FIG. 3 shows a third exemplary embodiment of the environmental conditions display system according to this invention;

FIG. 4 is a functional block diagram outlining an exemplary embodiment of the environmental conditions display system according to this invention;

FIG. 5 is a flowchart outlining one exemplary embodiment of a method for using the environmental conditions display system according to this invention;

FIG. 6 shows one exemplary embodiment of a display using the environmental conditions display system according to this invention;

FIG. 7 shows a second exemplary embodiment of a display using the environmental conditions display system according to this invention;

FIG. 8 shows a third exemplary embodiment of a display using the environmental conditions display system according to this invention; and

FIG. 9 shows a fourth exemplary embodiment of the environmental conditions display system according to this invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

For simplicity and clarification, the operating principles, design factors, and layout of the environmental conditions display systems, methods, and apparatuses according to this invention are explained with reference to various exemplary embodiments of environmental conditions display systems, methods, and apparatuses according to this invention. The basic explanation of the operation of the environmental conditions display systems, methods, and apparatuses is applicable for the understanding and design of the constituent components employed in the environmental conditions display systems, methods, and apparatuses of this invention.

Furthermore, it should be appreciated that, for simplicity and clarification, the embodiments of this invention will be described with reference to the environmental conditions display systems, methods, and apparatuses as they operate in an aircraft. Alternatively, the systems, methods, and apparatuses of this invention can be implemented in other vehicles, such as, for example, helicopters, watercraft, hovercraft, automotive vehicles, or the like.

It should also be appreciated that the term "environmental conditions" is for basic explanation and understanding of the operation of the environmental conditions display systems, methods, and apparatuses. Therefore, the term "environmental conditions" is not to be construed as limiting the environmental conditions display systems, methods, and apparatuses of this invention.

FIG. 1 shows an environmental conditions display system incorporating a first exemplary embodiment of an environmental conditions display system 100 according to this invention. As shown in FIG. 1, the environmental conditions display system 100 includes at least some of an aircraft 110, an environmental conditions database 120, and at least one environmental conditions transmitter 130.

The aircraft 110 includes at least some of a receiver 112, an aircraft characteristics database 114, a display generator

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116, and a display 118. In various exemplary embodiments, the display generator 116 interfaces, via the receiver 112, with the at least one environmental conditions transmitter 130. The display generator 116 also interfaces with the aircraft characteristics database 114 and the display 118.

In the various exemplary embodiments, the aircraft characteristics database 114 includes a database that stores static aircraft specific information and a database that stores dynamic aircraft specific information. In various exemplary embodiments, various systems and/or sensors of the aircraft 110 periodically update the dynamic aircraft specific information stored in the aircraft characteristics database 114.

In the various exemplary embodiments described herein, the display generator 116 is an environmental conditions display system 400, as shown below, with reference to FIG. 4. In various exemplary embodiments, the display generator 116 interfaces, for example, with the environmental conditions database 120, via a wireless link using the receiver 112 and the at least one environmental conditions transmitter 130. Alternatively, the display generator 116 can interface with the environmental conditions database 120, either directly or indirectly, via any linked connection. The linked connection can be any known or later developed device or system for connecting the display generator 116 to the environmental conditions database 120, including a direct wired connection, a connection over a LAN, a WAN, or any other distributed network, a connection over the public switched telephone network, a connection over a coaxial cable (i.e., CATV) system, a connection over a cellular telephone network, a very high frequency (VHF) connection, an ultra high frequency (UHF) connection, a radio frequency (RF) connection, a satellite connection, or the like. In general, the linked connection can be any known or later developed connection system or structure usable to connect the display generator 116 to the environmental conditions database 120, including both wired and wireless connections.

In various exemplary embodiments, the display generator 116 interfaces with the display 118. The display 118 can be a cathode ray tube display, a liquid crystal display, a plasma display, a light emitting diode (LED) display, or any other known or later developed system capable of displaying data.

In various exemplary embodiments, the at least one environmental conditions transmitter 130 is, for example, a VHF transmitter, a UHF transmitter, a RF transmitter, a satellite transmitter, or the like. When the at least one environmental conditions transmitter 130 is, for example, a satellite transmitter, the at least one environmental conditions transmitter 130 also includes at least one satellite 135. In various exemplary embodiments, the at least one environmental conditions transmitter 130 is, for example, a transmitter included in another aircraft that transmits environmental conditions information. Thus, in various exemplary embodiments, the receiver 112 includes at least one of a VHF antenna, a UHF antenna, a RF antenna, a satellite communications receiver, or the like.

During operation of the environmental conditions display system 100, the display generator 116, receives, via the receiver 112, signals from the at least one environmental conditions transmitter 130. The signals from the at least one environmental conditions transmitter 130 contain at least some environmental conditions data from the environmental conditions database 120. In various exemplary embodiments, the signals also include global positioning system (GPS) data, which allows the systems, methods, and apparatuses of this invention to determine the location

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and/or the speed of the aircraft. In the various exemplary embodiments, the display generator 116 includes an environmental conditions database that stores at least the received environmental conditions data from the environmental conditions database 120.

When the display generator 116 receives the environmental conditions data, the display generator 116 compares the environmental conditions data to the static and dynamic aircraft characteristics stored in the aircraft characteristics database 114, as described above, and determines whether there are any environmental conditions that exceed a determined threshold and will affect the aircraft. The display generator 116 then creates a display map that includes all of the environmental conditions that will affect the aircraft and sends the map to the display 118 to be displayed.

In various exemplary embodiments, the displayed map is automatically updated periodically to reflect changes not only to the aircraft location and the environmental conditions, but also to the aircraft characteristics, such as, for example, the reduced weight of the aircraft due to fuel consumption, payload discharge, or weapons release.

FIG. 2 shows an environmental conditions display system incorporating a second exemplary embodiment of an environmental conditions display system 200 according to this invention. As shown in FIG. 2, the environmental conditions display system 200 includes at least some of an aircraft 210, a receiver 212, an aircraft characteristics database 214, a display generator 216, and a display 218.

The elements of the environmental conditions display system 200 correspond to and operate similarly to the same elements discussed above with respect to the environmental conditions display system 100 of FIG. 1. However, in various exemplary embodiments, the environmental conditions display system 200 does not require the at least one environmental conditions transmitter 130 in order to receive the environmental conditions information.

In various exemplary embodiments of the environmental conditions display system 200, the display generator 216 receives, via the receiver 212, environmental conditions information from an onboard system or various onboard systems, such as, for example, an onboard system 213. In various exemplary embodiments, the onboard system 213 is a weather radar, an infrared (IR) sensor, a laser radar (LIDAR), or the like.

Thus, the environmental conditions display system 200 provides a map of an area based on the static and dynamic characteristics of the aircraft received from the aircraft characteristics database 214 and the environmental conditions information received from the onboard system 213, as described above.

FIG. 3 shows an environmental conditions display system incorporating a third exemplary embodiment of an environmental conditions display system 300 according to this invention. As shown in FIG. 3, the environmental conditions display system 300 includes at least some of an aircraft 310, a transceiver 312, an aircraft characteristics database 314, a display generator 316, a display 318, an environmental conditions database 320, and at least one remote transceiver 330.

The elements of the environmental conditions display system 300 correspond to and operate similarly to the same elements discussed above with respect to the environmental conditions display system 100 of FIG. 1. However, in various exemplary embodiments of the environmental conditions display system 300, the receiver 112, as shown in FIG. 1, is replaced with the transceiver 312. Furthermore, the display generator 316 is located remote from the aircraft 310.

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During operation, the environmental conditions display system 300 operates similarly to the environmental conditions display system 100, as shown in FIG. 1. However, the aircraft 310 transmits, via the transceiver 312, the aircraft specific information to the at least one remote transceiver 330. The at least one remote transceiver 330 then transfers the aircraft specific information to the display generator 316. The display generator 316 then prepares the display map using the aircraft specific information received from the aircraft 310 and the environmental conditions information received from the environmental conditions database 320, as described above, with reference to FIG. 1. When the display map is prepared, display map data is transferred, via the at least one remote transceiver 330, to the transceiver 312. The transceiver 312 then transfers the display map data to the display 318 to be displayed.

In this manner, the hardware and software needed to process the environmental conditions information and the aircraft specific information is stored remote from the aircraft 310. Thus, less space is required onboard the aircraft 310 for the environmental conditions display system 300.

FIG. 4 is a functional block diagram outlining an exemplary embodiment of an environmental conditions display system 400 according to this invention. As shown in FIG. 4, one exemplary embodiment of an environmental conditions display system 400 includes a computer or central processing unit (CPU) 410, one or more input devices 460, a display 470, a vehicle conditions database 480, and an environmental conditions database 490.

The computer or CPU 410 includes at least some of a vehicle information database 413, a map annotation database 420, an annotation injection circuit 423, a memory 430, a controller 435, a display manager 440, an input/output interface 445, and a data monitoring circuit 450. The computer or CPU 410 interfaces with the one or more input devices 460 and the display 470 through the input/output interface 445. Additionally, the computer or CPU 410 interfaces with both the vehicle conditions database 480 and the environmental conditions database 490, via a linked connection 495, through the input/output interface 445.

In various exemplary embodiments, the memory 430 can be implemented using any appropriate combination of alterable, volatile or non-volatile memory or non-alterable, or fixed, memory. The alterable memory, whether volatile or non-volatile, can be implemented using any one or more of non-selectable or dynamic RAM, a floppy disk and disk drive, a writable or re-writable optical disk and disk drive, a hard drive, flash memory or the like. Similarly, the non-alterable or fixed memory can be implemented using any one or more of ROM, PROM, EPROM, EEPROM, an optical ROM disk, such as a CD-ROM or DVD-ROM disk, and disk drive or the like.

In various exemplary embodiments, the memory 430 stores software and data including a software program and specific algorithms used by the environmental conditions display system 400. For example, the memory 430 stores map display software and communication software. Map display software and communications software are familiar to those of ordinary skill in the art.

The controller 435 manages reading data from and writing data to the memory 430. The controller 435 also drives the transmission of data to and the reception of data from the one or more input devices 460, the environmental conditions database 490, and the display 470, through the input/output interface 445.

The data monitoring circuit 450 monitors incoming data from the vehicle conditions database 480 and the environmental conditions database 490.

The vehicle conditions database 480 at least stores dynamic aircraft data specific to the particular aircraft that is being flown. In various exemplary embodiments, the dynamic aircraft data includes data about the aircraft characteristics that change during flight, such as, the aircraft's weight, performance characteristics, center of gravity, configuration, functionality of any automated control systems, or the like.

The environmental conditions database 490 includes information relating to weather and other environmental conditions. In various exemplary embodiments, the environmental conditions database 490 is located in the aircraft itself, and receives environmental condition information from, for example, an onboard radar system. In various other exemplary embodiments, the environmental conditions database 490 is a remote database, which transmits the environmental conditions information to the aircraft. In still other exemplary embodiments, the environmental conditions database 490 is an airborne database located in, for example, another aircraft or a satellite, which transmits the environmental conditions information to the aircraft.

The vehicle information database 415 at least stores static data specific to the particular aircraft that is being flown. In various exemplary embodiments, the static data includes data about the aircraft that does not change during flight, such as, the aircraft's size, propulsion, mode of propulsion, structure, type of control system(s) and surfaces, longitudinal and lateral aerodynamics, maximum weight, structural and mechanical limitations or the like.

The map annotation database 420 stores environmental condition annotations to be added to the maps stored in the memory 430. The environmental condition annotations might be, for example, a particular style or color of shading, or an icon that is displayed on a map to alert a pilot to certain environmental conditions, as described above. The annotation injection circuit 425 injects the environmental condition annotations in one or more appropriate locations, as dictated by the controller 435 and the vehicle information database 415, into the map or maps stored in the memory 430.

In various exemplary embodiments, the display manager 440 drives the display 470. The display 470 can be a cathode ray tube display, a liquid crystal display, a plasma display, a light emitting diode (LED) display, or any other known or later developed system capable of displaying data. The one or more input devices 460 can be one or more of a keyboard, a mouse, a touch screen, a switch, a knob, a button, an enable widget, a touch pad, a microphone or any other known or later developed device capable of inputting data.

In the various exemplary embodiments described herein, the computer or CPU 410 interfaces, for example, with the vehicle conditions database 480 and the environmental conditions database 490.

In the various exemplary embodiments described herein, the computer or CPU 410 interfaces, for example, with the environmental conditions database 490, through the linked connection 495 using the input/output interface 445. Alternatively, the computer or CPU 410 can interface with the environmental conditions database 490, through a direct wired connection. The linked connection 495 can be any known or later developed device or system for connecting the computer or CPU 410 to the environmental conditions database 490, including a wireless link, a connection over a LAN, a WAN, or any other distributed network, a connection over the public switched telephone network, a connection over a coaxial cable (i.e., CATV) system, a connection over a cellular telephone network, a very high frequency

(VHF) connection, an ultra high frequency (UBF) connection, a radio frequency (RF) connection, a satellite connection, or the like. In general, the linked connection 495 can be any known or later developed connection system or structure usable to connect the computer or CPU 410 to the environmental conditions database 490, including both wired and wireless connections.

In the various exemplary embodiments described herein, the computer or CPU 410 interfaces, for example, with the one or more input devices 460 and/or the display 470, through a direct wired connection. Alternatively, the computer or CPU 410 can interface with the one or more input devices 460 and/or the display 470, through a linked connection, as described above, using the input/output interface 445.

In various exemplary embodiments, the environmental conditions display system 400 will be included as part of the software executing on the computer or CPU. It should be appreciated that any other known or later developed system capable of processing and outputting data could be used in place of the computer or CPU. While generating environmental conditions annotations based on environmental conditions information and vehicle specific information is not currently known, appropriate software for coordinating with, for example, the display 470 and displaying the graph data included in the environmental conditions annotations is elementary, and essentially the same as found in the prior art systems.

During operation of one exemplary embodiment of the environmental conditions display system 400, the input/output interface 445 receives aircraft specific information from the aircraft conditions database 480 and environmental conditions information from the environmental conditions database 490. As the environmental conditions display system 400 receives the aircraft specific information and the environmental conditions information, the data monitoring circuit 450 monitors all of the information that is contained in the received aircraft specific and environmental conditions information.

The controller 435 then sends the aircraft specific and environmental conditions information to the memory 430, where information from the vehicle information database 415 and the map annotation database is included. The algorithms within the memory 430 then determine appropriately iconized environmental conditions annotations for each environmental condition that is strong enough to affect the aircraft, as described above.

As appropriate environmental conditions annotations are determined, the annotation injection circuit 425 injects the appropriate environmental conditions annotations in one or more appropriate locations in appropriate map information stored in the memory 430.

The map information including the appropriate environmental conditions annotations is then sent to the display manager so that an environmental conditions display map can be produced. Once the environmental conditions display map is produced, the environmental conditions display map is transmitted, through the input/output interface 445, to the display 470.

When the environmental conditions display map is displayed, the pilot can use the one or more input devices 460 to alter the display field as further described herein.

FIG. 5 is a flowchart outlining one exemplary embodiment of a method for using the environmental conditions display system according to this invention. In various exemplary embodiments, as environmental conditions informa-

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tion is received, a display map is created and/or updated to show the environmental conditions as the environmental conditions relate to a particular vehicle.

In various exemplary embodiments, environmental condition annotations include one or more styles or colors of shading, or icons that are displayed on the display map to alert the user to certain environmental conditions, as described above. Additionally, custom environmental condition annotations can be added as dictated by the user.

As shown in FIG. 5, beginning in step S100, control continues to step S105 where environmental conditions information is received. Then, in step S110, vehicle information is received. Next, in step S115, the received environmental conditions information is combined with the received vehicle information and with stored vehicle specific information. Control then continues to step S120.

In step S120, a determination is made whether any of the received environmental conditions information represent environmental conditions that are severe enough to affect the particular vehicle. If, in step S120, it is determined that none of the environmental conditions are severe enough to affect the particular vehicle, control advances to step S125. Otherwise, control jumps to step S130.

In step S125, a display map is produced that does not include any environmental condition annotations. Control then jumps to step S140.

In step S130, appropriate characteristics, such as, for example, shading, coloring, iconization, or the like, are determined to reflect the spatial extent and severity of each environmental conditions annotation that represents an environmental condition that is severe enough to affect the particular vehicle. Then, in step S135, a display map is produced that includes an appropriate environmental condition annotation for each environmental condition that is severe enough to affect the particular vehicle. Control then continues to step S140 where the method ends.

It should be understood that the method for using the environmental conditions display system described above can be implemented such that the method restarts either at predetermined time intervals, at the request of a user, when the environmental conditions information is updated, or when certain predetermined vehicle information changes.

In various exemplary embodiments, the display map can be stored in a memory, such as, for example, the memory 430 of the computer or CPU 410 described above with reference to FIG. 4. Additionally, the vehicle specific information and the environmental conditions annotations can be stored in a vehicle information database and a map annotation database, such as, for example, the vehicle information database 415 and the map annotation database 420, respectively, as described above with reference to FIG. 4.

FIG. 6 shows one exemplary embodiment of a display using the environmental conditions display system according to this invention. As shown in FIG. 6, the environmental conditions display system 600 includes at least some of a map display portion 605, a legend portion 630, a flight conditions display portion 640, a flight planning/update portion 650, a map display functions portion 660, and/or a display update/replay portion 670.

The map display portion 605 includes at least some of a background map of an area, a flight path line 610, and a reference icon 615 indicating the aircraft's present position and direction along the flight path line 610. The map display portion may also include at least one environmental condition annotation 620 displayed over the background map of the area.

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In various exemplary embodiments, the legend portion 630 includes a list of environmental conditions. Each environmental condition is associated with a displayed annotation, such as, for example variable coloring, shading pattern, or iconization. These annotations are used by the environmental conditions display system 600 to alert the pilot to a variety of environmental conditions, as described above. In this manner, the pilot does not have to remember what each of the annotations represents, but is able to quickly reference each displayed environmental condition annotation.

In various exemplary embodiments, the flight conditions display portion 640 includes some of a present altitude display 642, a displayed altitude display 644, and displayed altitude adjustment enable widgets 647 and 649. The present altitude display 642 shows the present altitude of the aircraft. In contrast, the displayed altitude display 644 shows the altitude of the environmental conditions displayed in the map display portion 605. The displayed altitude adjustment enable widgets 647 and 649 allow the pilot to increase or decrease the altitude of the environmental conditions displayed in the map display portion 605. Thus, the pilot is able to investigate the environmental conditions at various altitudes without changing the altitude of the aircraft.

In various exemplary embodiments, the flight conditions display portion 640 also includes a present altitude enable widget, not shown. The present altitude enable widget allows the pilot to automatically return the display to the aircraft's present altitude. Alternatively, this present altitude display function could be accomplished, for example, by depressing both of the displayed altitude adjustment enable widgets 647 and 649 simultaneously.

In various exemplary embodiments, the flight planning/update portion 650 includes some of a plan/update route enable widget 652, a planning option enable widget 654, and a planning option display 655. Selection of the plan/update route enable widget 652 allows the pilot to, for example, input a departure and arrival point and allow the environmental conditions display system 600 to determine a route of travel. The route would be determined using the environmental conditions data and the aircraft information data as described above.

If the aircraft is in flight, or if a route has been planned, the plan/update route enable widget 652 can update, and alter if necessary, the route using updated environmental and aircraft information data.

The planning option enable widget 654 allows the pilot to select the criteria that the plan/update route function uses to determine and/or update the route. For example, if the pilot selects a speed function, the plan/update route function will determine the fastest route from the departure point (or the present position) to the destination, while accounting for the environmental conditions and the aircraft characteristics as described above. If the pilot selects a comfort function, the plan/update route function will determine the least turbulent route from the departure point (or the present position) to the destination, while accounting for the environmental conditions and the aircraft characteristics as described above. Alternatively, the pilot may merely choose an update function, which allows the plan/update route function to update the flight route without changing planning options.

The planning option display 655 allows the pilot to determine which of the planning functions is being used by the plan/update route function to plan/update the route.

In various exemplary embodiments, the map display functions portion 660 includes some of a show present

position enable widget 664, a zoom in enable widget 665, a zoom out enable widget 666, and a display scroll enable widget 662. By using the functions of the map display functions portion 660, the pilot is able to view various maps or various sections of the map display portion 605 in greater or less detail. For example, the zoom in and zoom out enable widgets 665 and 666, respectively, allow the pilot to increase or decrease the area displayed by the map display portion 605.

Similarly, the scroll enable widget 662 allows the pilot to maintain a constant zoom factor while moving the area shown in the map display portion 605 up, down, right, or left. The show present position enable widget 664 allows the pilot to return the map display portion 605 to a view that shows the present position of the aircraft, for example, in the center of the map display portion 605.

In various exemplary embodiments, the display update/replay portion 670 includes some of an auto update enable widget 672, an update frequency enable widget 673, a replay enable widget 674, and a replay time set enable widget 675. By selecting the auto update enable widget 672, the environmental conditions display system 600 will automatically retrieve environmental conditions and aircraft information data and update any environmental condition annotation 620 and/or the flight path 610 as necessary.

The update frequency enable widget 673 allows the pilot to determine how frequently the environmental conditions display system 600 automatically updates.

In various exemplary embodiments, the environmental conditions display system 600 also includes a replay enable widget 674. The replay enable widget 674 allows the environmental conditions display system 600 to recall at least the aircraft positioning information and the environmental conditions information from a determined number of updates and display the information sequentially. Thus, the environmental conditions display system 600 produces an animated display map that allows the pilot to see the way in which various environmental conditions have developed over the determined period of time.

The replay time set enable widget 675 allows the pilot to determine how far back in time the replay function will go to retrieve the environmental conditions data to be displayed.

For example, as shown in FIG. 6, the update frequency function is set to automatically update every two minutes, while the replay time set function is set to include the update information received in the last ten minutes in an animated replay. Thus, if the pilot selects the replay enable widget 674 with these settings, the environmental conditions display system 600 will produce an animated display map consisting of five frames (one for each update) showing any changes in the environmental conditions for the last ten minutes.

Map display software and the display manipulation features described above, such as, for example, the zoom in, zoom out, and route planning/updating functions are familiar to even the lay person who accesses or operates a commercially available map program.

It should be understood that the enable widgets described herein can be any known or later developed mechanism or display for allowing a user to select a particular item or function on a display, such as, for example, a switch, a knob, a dial, a check box, a mark box, a radio button, an enable widget, or the like.

The environmental conditions display system 600 shown in FIG. 6 shows an example of the environmental conditions display system 600 as the environmental conditions display

system 600 might appear in a large, passenger aircraft, such as, for example, a Boeing® 777-300™. The environmental condition annotations 620 appear as they might after the systems, methods, and apparatuses of this invention processed received environmental conditions information with reference to aircraft information specific to the Boeing® 777-300™ flying at an altitude of 5,000 feet.

It should also be understood that the actions that can be performed by the environmental conditions display system 600 of this invention are not limited to the actions listed above. The environmental conditions display system 600 of this invention can perform any actions that can be performed by software executing on a programmed general purpose computer, a special purpose computer, a microprocessor or the like.

FIG. 7 shows a second exemplary embodiment of a display using the environmental conditions display system according to this invention. As shown in FIG. 7, the environmental conditions display system 700 includes at least some of a map display portion 705, at least one environmental condition annotation 720, a legend portion 730, a flight conditions display portion 740, a flight planning/update portion 750, a map display functions portion 760, and/or a display update/refresh portion 770.

The environmental conditions display system 700 functions similarly to the environmental conditions display system 600, as described above with respect to FIG. 6. However, the environmental conditions display system 700, shown in FIG. 7, is an example of how the map display portion 705 might appear when the pilot uses the altitude adjustment enable widgets 747 and 749 to adjust the displayed altitude.

As shown in FIG. 7, the environmental condition annotations 720 appear as they might after the systems, methods, and apparatuses of this invention process the same environmental conditions data as processed in FIG. 6. Yet, as shown in FIG. 7, the environmental conditions data is processed with reference to aircraft information specific to the Boeing® 777-300™ flying at an altitude of 15,000 feet instead of flying at an altitude of 5,000 feet.

Thus, as shown in FIG. 7, the environmental condition annotations 720 encompass a smaller area than the environmental condition annotations 620, as shown in FIG. 6. The environmental condition annotations 720 reflect a change in the environmental conditions as compared to FIG. 6 because the environmental condition change for a particular aircraft as the aircraft changes altitude, as described above.

FIG. 8 shows a third exemplary embodiment of a display using the environmental conditions display system according to this invention. As shown in FIG. 8, the environmental conditions display system 800 includes at least some of a map display portion 805, at least one environmental condition annotation 820, a legend portion 830, a flight conditions display portion 840, a flight planning/update portion 850, a map display functions portion 860, and/or a display update/refresh portion 870.

The environmental conditions display system 800 functions similarly to the environmental conditions display system 600, as described above with respect to FIG. 6. However, the environmental conditions display system 800, shown in FIG. 8, shows an example of how the map display portion 805 might appear in a small, single-engine aircraft, such as, for example, a Cessna® 172R™ Skyhawk™. The environmental condition annotations 820 appear as they might after the systems, methods, and apparatuses of this invention process the same environmental



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conditions data as processed in FIG. 6. Yet, as shown in FIG. 8, the environmental conditions data is processed with reference to aircraft information specific to the Cessna® 172R™ Skyhawk™ flying at an altitude of 5,000 feet instead of the Boeing® 777-300™ flying at an altitude of 5,000 feet.

Thus, when comparing FIG. 8 to FIG. 6, the environmental condition annotations 820, shown in FIG. 8, encompass a larger area than the environmental condition annotations 620, shown in FIG. 6. The changes to the environmental condition annotations 620 and 820 do not reflect a change in the environmental conditions or the altitude of the aircraft. To the contrary, the changes to the environmental condition annotations are due to the characteristics of the smaller aircraft.

FIG. 9 shows a fourth exemplary embodiment of the environmental conditions display system according to this invention. As shown in FIG. 9, the environmental conditions display system 900 includes at least some of a watercraft 910, a receiver 912, a display generator 914, a display 916, and at least one environmental conditions transmitter 920.

The environmental conditions display system 900 functions similarly to the environmental conditions display system 100, as described above with respect to FIG. 1. However, in various exemplary embodiments, the environmental conditions display system 900 receives environmental conditions information and processes the received environmental conditions information with reference to watercraft specific information to produce a display that shows environmental conditions annotations for environmental conditions that would affect the specific watercraft.

In various exemplary embodiments of the environmental conditions display system 900, the environmental conditions display system 900 functions similarly to the environmental conditions display systems 100 and 200, as described above with respect to FIGS. 1 and 2. Additionally, in various exemplary embodiments, the environmental conditions display system 900 employs a display similar to the environmental conditions display systems 600, 700, and/or 800, as described above with respect to FIGS. 6, 7, and 8. However, in various exemplary embodiments, the environmental conditions display system 900 also includes environmental conditions annotations that reflect nautical environmental conditions, such as, for example, wind speed at sea level, nautical currents, water depth, and wave height.

It should be understood that although some environmental conditions, such as lightning, fog, and/or restricted areas, affect all aircraft regardless of the specific characteristics of the aircraft, the systems, apparatuses, and methods of this invention display appropriate symbols and/or icons to represent the environmental conditions that represent a universal hazard to all aircraft.

It should also be understood that each of the elements of the environmental conditions display system can be implemented as portions of a suitably programmed general-purpose computer. Alternatively, each of the elements of the environmental conditions display system can be implemented as physically distinct hardware circuits within an ASIC, or using a FPGA, a PDL, a PLA or a PAL, or using discrete logic elements or discrete circuit elements. The particular form that each of the elements of the environmental conditions display system will take is a design choice and will be obvious and predicable to those skilled in the art.

Moreover, the environmental conditions display system can be implemented as software executing on a programmed general-purpose computer, a special purpose computer, a microprocessor or the like.

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Thus, in summary, the environmental conditions display system can be implemented on a programmed general purpose computer, a special purpose computer, a programmed microprocessor or microcontroller and peripheral integrated circuit elements, an ASIC or other integrated circuit, a digital signal processor, a hardwired electronic or logic circuit such as a discrete element circuit, a programmable logic device such as a PLD, PLA, FPGA or PAL, or the like. In general, any device, capable of implementing a finite state machine that is in turn capable of implementing the flowchart shown in FIG. 5 can be used to implement the environmental conditions display system.

While this invention has been described in conjunction with the exemplary embodiments outlined above, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, the exemplary embodiments of the invention, as set forth above, are intended to be illustrative, not limiting. Various changes may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A method of displaying environmental conditions as the environmental conditions relate to a particular vehicle, comprising:

- receiving environmental conditions information;
- receiving vehicle information;
- receiving vehicle specific information;
- determining, based on the received environmental conditions information, the received vehicle information, and the received vehicle specific information, whether any environmental conditions represent environmental conditions that are severe enough to affect the particular vehicle;
- creating, if the environmental conditions represent environmental conditions that are severe enough to affect the particular vehicle, at least one environmental condition annotation for each environmental condition that represents an environmental condition that is severe enough to affect the particular vehicle; and
- inserting the at least one environmental condition annotation in an appropriate location on a display device.

2. The method of claim 1, wherein receiving environmental conditions information includes receiving information regarding at least one of cloud type, cloud altitude, visibility, storms, rain, turbulence, lightning, icing, fog, volcanic ash, wind speed, wind direction, wind variation, ~~water depth~~, water conditions, water temperature, wave height, water current, water undercurrent, accumulated precipitation, restricted areas, surface conditions, road conditions and grade of terrain traversed.

3. The method of claim 1, wherein receiving environmental conditions information includes receiving environmental conditions information from at least one ground-based source.

4. The method of claim 1, wherein receiving environmental conditions information includes receiving environmental conditions information from at least one satellite.

5. The method of claim 1, wherein receiving environmental conditions information includes receiving environmental conditions information from at least one other vehicle.

6. The method of claim 1, wherein receiving environmental conditions information includes receiving environmental conditions information from at least one system onboard the particular vehicle.

7. The method of claim 1, wherein receiving vehicle information includes receiving dynamic vehicle information.

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8. The method of claim 1, wherein receiving vehicle specific information includes receiving static vehicle information.

9. The method of claim 1, wherein creating at least one environmental condition annotation includes creating at least one icon or symbol having characteristics that reflect the spatial extent and severity of the environmental condition.

10. The method of claim 9, wherein creating at least one icon or symbol having characteristics that reflect the spatial extent and severity of the environmental condition includes creating the at least one icon or symbol using at least one of specific shading, coloring, and patterning techniques.

11. A method of planning or updating a travel route based on a potential affect of environmental conditions on a particular vehicle, comprising:

receiving at least a starting location of a journey and an end point of a journey;

determining a best travel route from at least the starting location of the journey to the end point of the journey;

receiving environmental conditions information for at least the determined best travel route;

receiving vehicle information;

receiving vehicle specific information;

determining, based on the determined best travel route, the received environmental conditions information, the received vehicle information, and the received vehicle specific information, whether any environmental conditions represent environmental conditions that are severe enough to affect the particular vehicle;

re-determining, if any environmental conditions represent environmental conditions that are severe enough to affect the particular vehicle, the best travel route to traverse the environmental conditions that represent environmental conditions that are severe enough to affect the particular vehicle; and

creating a display that shows at least the determined best travel route and at least one environmental condition annotation that represents each environmental condition that is severe enough to affect the particular vehicle.

12. The method of claim 11, wherein re-determining the best travel route includes re-determining the best travel route based on a selected criteria.

13. The method of claim 12, wherein the selected criteria include at least one of, total avoidance of any environmental conditions severe enough to affect the particular vehicle, best fuel economy, most comfortable ride, fastest traverse of a particular region, and changing configuration of the vehicle.

14. An apparatus for displaying environmental conditions as the environmental conditions relate to a particular vehicle, comprising:

a display;

an input circuit that receives incoming information;

a vehicle information database that at least stores static data specific to the particular vehicle;

a vehicle conditions database that at least periodically receives and stores dynamic data specific to the particular vehicle;

an environmental conditions database that at least periodically receives and stores weather and other environmental conditions information;

a map annotation database that stores environmental condition annotations;

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an annotation injection circuit that injects appropriate environmental condition annotations in one or more appropriate locations on the display;

a memory that contains at least a software program and specific algorithms used by the environmental conditions display apparatus;

an output circuit that outputs the environmental condition annotations to the display; and

a controller coupled to the display, the input circuit, the vehicle information database, the vehicle conditions database, the environmental conditions database, the map annotation database, the memory, and the output circuit, and configured to determine, based on the specific algorithms, the static data, the dynamic data, and the weather and other environmental conditions information, whether any environmental conditions represent environmental conditions that are severe enough to affect the particular vehicle, to create, using the environmental condition annotations, at least one environmental condition annotation for each environmental condition that represents an environmental condition that is severe enough to affect the particular vehicle, and to control the annotation injection circuit to inject, via the output circuit, appropriate environmental condition annotations in one or more appropriate locations on the display.

15. The apparatus of claim 14, wherein the display also displays a best travel route on the display from at least one first location to at least one second location.

16. The apparatus of claim 14, wherein the weather and other environmental conditions information includes at least one of instrument meteorological conditions, visual meteorological conditions, cloud type, cloud altitude, visibility, storms, rain, turbulence, lightning, icing, fog, volcanic ash, wind speed, wind direction, wind variation, ~~wave~~ water conditions, water temperature, wave height, water current, water undercurrent, accumulated precipitation, restricted areas, surface conditions, road conditions and grade of terrain traversed.

17. The apparatus of claim 14, wherein the static data includes at least one of the vehicle's size, propulsion, mode of propulsion, structure, type of control system(s), control surfaces, longitudinal and lateral aerodynamics, maximum weight, maximum operational ceiling, maximum Mach number, structural limitations, mechanical limitations, and performance limitations.

18. The apparatus of claim 14, wherein the dynamic data includes data about at least one of the vehicle's weight, performance characteristics, center of gravity, configuration, functionality of any automated control systems, speed, and direction.

19. The apparatus of claim 14, wherein the environmental condition annotations include a particular style or color of at least one of patterning, shading, and iconization.

20. The apparatus of claim 19, wherein each particular style or color of patterning, shading, or iconization represents a different spatial extent or severity of an environmental condition.

21. The apparatus of claim 14, wherein the memory also stores map display software and communications software.

22. The apparatus of claim 14, wherein the environmental conditions database is located onboard the vehicle.

23. The apparatus of claim 14, wherein the environmental conditions database is located onboard another vehicle.

24. The apparatus of claim 14, wherein the environmental conditions database is located remote from the vehicle.

25. The apparatus of claim 14, wherein the environmental conditions database receives weather and other environmen-



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tal conditions information from at least one system that is remote from the vehicle.

26. The apparatus of claim 14, wherein the environmental conditions database receives weather and other environmental conditions information from at least one system that is onboard the vehicle.

27. The apparatus of claim 14, further including one or more input devices to update or alter the display.

28. An environmental conditions display system that displays environmental conditions as the environmental conditions relate to a particular vehicle, comprising:

a display;

an input circuit that receives incoming information;

a vehicle information database that at least stores static data specific to the particular vehicle;

a vehicle conditions database that at least periodically receives and stores dynamic data specific to the particular vehicle;

an environmental conditions database that at least periodically receives and stores weather and other environmental conditions information;

a map annotation database that stores environmental condition annotations;

an annotation injection circuit that injects appropriate environmental condition annotations in one or more appropriate locations on the display;

a memory that contains at least a software program and specific algorithms used by the environmental conditions display apparatus;

an output circuit that outputs the environmental condition annotations to the display; and

a controller coupled to the display, the input circuit, the vehicle information database, the vehicle conditions database, the environmental conditions database, the map annotation database, the memory, and the output circuit, and configured to determine, based on the specific algorithms, the static data, the dynamic data, and the weather and other environmental conditions information, whether any environmental conditions represent environmental conditions that are severe enough to affect the particular vehicle, to create, using the environmental condition annotations, at least one environmental condition annotation for each environmental condition that represents an environmental condition that is severe enough to affect the particular vehicle, and to control the annotation injection circuit to inject, via the output circuit, appropriate environmental condition annotations in one or more appropriate locations on the display.

29. The environmental conditions display system of claim 28, wherein the weather and other environmental conditions information includes at least one of cloud type, cloud altitude, visibility, storms, rain, turbulence, lightning, icing, fog, volcanic ash, wind speed, wind direction, wind variation, water depth, water conditions, water temperature, wave height, water current, water undercurrent, accumulated precipitation, restricted areas, surface conditions, road conditions and grade of terrain traversed.

30. The environmental conditions display system of claim 28, wherein the display also displays a best travel route on the display from at least one first location to at least one second location.

31. The environmental conditions display system of claim 28, wherein the static data includes at least one of the vehicle's size, propulsion, mode of propulsion, structure,

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type of control system(s), control surfaces, longitudinal and lateral aerodynamics, maximum weight, maximum operational ceiling, maximum Mach number, structural limitations, mechanical limitations, and performance limitations.

32. The environmental conditions display system of claim 28, wherein the dynamic data includes data about at least one of the vehicle's weight, performance characteristics, center of gravity, configuration, functionality of any automated control systems, speed, and direction.

33. The environmental conditions display system of claim 28, wherein the environmental condition annotations include a particular style or color of patterning, shading, or iconization.

34. The environmental conditions display system of claim 30, wherein each particular style or color of patterning, shading, or iconization represents a different spatial extent or severity of an environmental condition.

35. The environmental conditions display system of claim 28, wherein the memory also stores map display software and communications software.

36. The environmental conditions display system of claim 28, wherein the environmental conditions database is located onboard the vehicle.

37. The environmental conditions display system of claim 28, wherein the environmental conditions database is located onboard another vehicle.

38. The environmental conditions display system of claim 28, wherein the environmental conditions database is located remote from the vehicle.

39. The environmental conditions display system of claim 28, wherein the environmental conditions database receives weather and other environmental conditions information from at least one system that is remote from the vehicle.

40. The environmental conditions display system of claim 28, wherein the environmental conditions database receives weather and other environmental conditions information from at least one system that is onboard the vehicle.

41. The environmental conditions display system of claim 28, further including one or more input devices to update or alter the display.

42. A method of displaying environmental conditions as the environmental conditions relate to a particular vehicle, comprising the steps of:

receiving at least some static vehicle information from at least one second vehicle;

receiving at least some dynamic vehicle information from the at least one second vehicle;

comparing at least some of the static vehicle information and at least some of the dynamic vehicle information received from the at least one second vehicle to at least some static vehicle information and at least some dynamic vehicle information from the particular vehicle;

determining, based on the compared information, whether there are any environmental conditions that are severe enough to affect the particular vehicle;

creating, if it is determined that there are environmental conditions that are severe enough to affect the particular vehicle, at least one environmental condition annotation for each environmental condition that represents an environmental condition that is severe enough to affect the particular vehicle; and

producing a display of environmental conditions, wherein the display of environmental conditions includes the at least one environmental condition annotation inserted

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in an appropriate location on a display so as to indicate a relationship between the environmental condition and the particular vehicle.

43. The method of claim 42, wherein the dynamic vehicle information includes at least one of the vehicle's weight, performance characteristics, center of gravity, configuration, functionality of any automated control systems, location, speed, direction, altitude, and Mach number.

44. The method of claim 42, wherein the static vehicle information includes at least one of the vehicle's size, propulsion, mode of propulsion, structure, type of control system(s), type of control surfaces, longitudinal aerodynamics, lateral aerodynamics, maximum weight, structural limitations, mechanical limitations, performance limitations, maximum operational ceiling, and maximum Mach number.

45. The method of claim 42, wherein at least some of the static vehicle information or at least some of the dynamic vehicle information from the particular vehicle is predetermined static or dynamic vehicle information.

46. The method of claim 42, wherein at least some of the static vehicle information or at least some of the dynamic vehicle information from the at least one second vehicle is predetermined static or dynamic vehicle information.

47. The method of claim 42, wherein the display of environmental conditions as the environmental conditions relate to the particular vehicle is based on at least some present static vehicle information or at least some present dynamic vehicle information.

48. The method of claim 42, wherein the display of environmental conditions as the environmental conditions relate to the particular vehicle is based on at least some projected static vehicle information or at least some projected dynamic vehicle information for the particular vehicle when the particular vehicle reaches a location of the at least one second vehicle, wherein the location of the at least one second vehicle is the location from which the at least one second vehicle transmitted the static vehicle information or the projected dynamic vehicle information that is being compared.

49. The method of claim 42, wherein at least one of the static vehicle information and the dynamic vehicle informa-

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tion from at least one second vehicle is received from a source remote from the at least one second vehicle.

50. The method of claim 42, wherein the display of environmental conditions includes at least one environmental condition annotation for each environmental condition that is severe enough to affect the particular vehicle and wherein the at least one environmental condition annotation is inserted in an appropriate location on a display device to represent the location and severity of the environmental condition, as the location and the severity relate to the particular vehicle.

51. A method of providing environmental conditions data as the environmental conditions data relates to a particular vehicle, comprising the steps of:

receiving at least some static vehicle information from the particular vehicle;

receiving at least some dynamic vehicle information from the particular vehicle;

receiving at least some static vehicle information from at least one second vehicle;

receiving at least some dynamic vehicle information from the at least one second vehicle;

comparing at least some of the static vehicle information and at least some of the dynamic vehicle information received from the at least one second vehicle to at least some of the static vehicle information and at least some of the dynamic vehicle information from the particular vehicle;

determining environmental conditions data that relates to the particular vehicle,

wherein the determined environmental conditions data is based on the comparison of the at least some static vehicle information and the at least some dynamic vehicle information received from the at least one second vehicle to the at least some static vehicle information and the at least some dynamic vehicle information from the particular vehicle; and

transmitting the environmental conditions data to at least one vehicle.

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